THE ATLANTA ECONOMIC REVIEW

NOVEMBER, 1958
VOL. VIII NO. 11

# DID THE SUPREME COURT "COOL OFF" THE "HOT CARGO" PROVISIONS IN COLLECTIVE BARGAINING AGREEMENTS?

by

**Kenneth U. Flood***

## Introduction

Of great significance to the motor carrier industry is a recent Supreme Court labor case, *United Brotherhood of Carpenters v. N.L.R.B.*, decided in June of this year.[1] In question was the validity of the so-called "hot cargo" provisions found in teamsters and other unions contracts. The essence of these provisions is that employees may refrain from handling "unfair" goods, i.e., goods handled, processed, or manufactured by an employer engaged in a labor dispute. The hot cargo issue has been particularly controversial in the trucking industry inasmuch as common carriers have a duty to serve all on a nondiscriminatory basis.

The Labor Management Relations Act added Section 8(b) (4) (A), which was intended to outlaw many if not all of the types of pressure normally associated with the term "secondary boycott."[2] The expression of the concept of secondary boycotts has had a long and confusing history. It was so difficult to define precisely that Congress avoided its use in the final draft of the Taft-Hartley Act, despite the fact that the committee reports and floor debates all indicate that it was the "secondary boycott" which Section 8(b) (4) (A) was intended to prevent.[3] The enacted provision contained a narrower, technical language which presented the N.L.R.B. and the courts with the problem of determining whether a certain situation falls within the statutory prohibition rather than whether the activity is traditionally known as a "secondary boycott."[4]

The purpose of this article is to develop a brief history of the hot cargo and the common carrier duty-to-serve controversies, and to analyze the very recent Supreme Court decision previously mentioned which concerns these controversies. The ultimate conclusion involves the combining of two somewhat unrelated series of cases—one series involving a development of the common carrier's duty to serve under the Interstate Commerce Act and the other issue concerning the question of whether the hot cargo clause violated the terms of Section 8(b) (4)-(A) of the Labor Management Relations Act.

## Legal History—Hot Cargo Clause—Section 8(b) (4) (A)

As part of a policy of self-protection, the hot-

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1. 78 S. Ct. 1011 (1958).

2. Section 8(b)(4)(A), 29 U.S.C. Sec. 158 (b)(4)(A) reads: (b) It shall be an unfair labor practice for a labor organization or its agents . . . (4) to engage in, or to induce or encourage the employees of any employer to engage in a strike or a concerted refusal in the course of their employment to . . . transport, or therewise handle . . . any goods, . . . or to perform any services, where an object thereof is: (A) forcing or requiring . . . any employer or other person to cease . . . handling, transporting, or otherwise dealing in the products of any other producer . . . , or the cease of doing business with any other person; . . .

3. 54 Michigan Law Review, p. 255 (1955).

4. An excellently phrased definition of a secondary boycott is that of Judge Learned Hand in interpreting Section 8 (b)(4)(A) in I.B.E.W., Local 501 v. N.L.R.B., 181 Fed. 2d. 34, 37 (CA-2, 1950), aff'd. 341 U. S. 694 (1951): "the gravamen of a 'secondary boycott' is that its sanctions bear, not upon employer who alone is a party to dispute, but upon some party who has no concern in dispute, and its aim is to compel him to stop business with employer in hope that employer will be induced to give in to demands of employees."

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cargo clause is a union attempt to remove boycott activities from the prohibitions contained in Section 8(b) (4) (A).[5] To violate this section, the union must induce the employees to engage in a "strike or concerted refusal" to work in order to be charged with "forcing" the secondary employer to cease doing business with the primary employer. The union contends that an employer, by signing the collective bargaining agreement, consents in advance to his employees' refusal to handle such cargo and therefore is outside the proscription of Section 8(b) (4) (A).

The first significant decision dealing with the legality of hot cargo clauses was the *Conway Express* case in 1949. The majority of the National Labor Relations Board concluded that neither the signing nor the enforcement of a hot cargo contract violated the law. This initial N.L.R.B. position was based on the strict interpretation that, since the employer had agreed not to handle struck goods, the enforcement of the hot cargo clause by workers could not constitute a "strike or concerted refusal" "forcing or requiring" employers to boycott the struck goods, and the action was not violative of Section 8(b) (4) (A).[6] The Conway decision was given added importance in *Pittsburgh Plate Glass Company* case.[7] Here the Board decided that direct appeals to workers by union leaders to enforce these clauses did not fall within the statutory prohibitions. The Board's rationale was that to have a violation of Section 8(b) (4) (A), the employees must be found to be within the "course of employment" requirement of the Act, and since "hot" goods are exempt from being handled under the contract, those goods are not within the "course of employment" requirement.

After the N.L.R.B, had been reconstituted in 1954 by the appointment of a new chairman and two new members, the issue was raised again in the *McAllister Transfer* case.[8] This time the Board split three ways. Two members adhered to the Conway Express doctrine; and two went to the other extreme, adopting the view that hot cargo clauses are of themselves unlawful and not a defense to a secondary-boycott charge. The fifth member took a middle position, stating that the hot cargo agreement was not of itself invalid, but that the union, nevertheless, violated the law when it induced the employees of the neutral employers not to handle the "unfair" goods after their employers had given instructions that the goods should be handled.

5. Put in more colorful language, "The hot cargo arrangement is nothing more than the old secondary boycott clothed in a new raiment of would-be-respectability. But the sheep's clothing should not conceal the wolf from the eyes of the law." Lloyd & Wessel, "Public Policy and Secondary Boycotts," 23 U. of Cinn. L.R. 31, at 34 (1954).

6. **International Brotherhood of Teamsters, Chauffeurs, Warehousemen & Helpers of America, Local 294 v. Rabourn, 87 N.L.R.B. 972 (1949), aff'd Rabourn v. N.L.R.B. 195 F. 2d 906 (C.A. 2d, 1952).**

7. 105 N.L.R.B. 740 (1953).

8. Teamsters, A.F.L. (McAllister Transfer, Inc.), 110 N.L.R.B. 1796 (1954).

The Board anchored its consideration of the issue on the premise that Section 8(b) (4) (A) was specifically intended to protect the public interest, as distinguished from purely private rights; that under the circumstances the secondary employers could not, as a matter of law, waive the provisions of the Act which effectuate that policy. The Board further stated that private parties should not be permitted to accomplish by agreement that which is clearly deemed inimical to the public by congressional enactment.[9]

The doctrine of the *McAllister Transfer* case was crystallized in the *Sand Door* case, decided the following year.[10] The Board position in this case was that hot cargo clauses were valid only to the extent that they govern relations between the contracting parties. The basic purpose and objective of Section 8(b) (4) (A) of the Act is to prohibit the involvement of employers in labor disputes of other employers with whom they are doing business.[11] Therefore, regardless of the existence of a hot cargo clause, any direct appeal to employees by a union to engage in a strike or concerted refusal to handle a product is proscribed in the Act

9. Id. at 1779. The majority cited Senate Report No. 105 on S. 1126, p. 8, 80th Cong., 1st Sess. (1947).

10. **United Brotherhood of Carpenters, AFL, 113 N.L.R.B. 1210 (1955) aff'd, N.L.R.B. v. Local 1976, United Brotherhood of Carpenters, AFL, 241 F.2d 147 (9th Cir. 1957), cert. granted, 355 U.S. 808 (1957).**

11. Id. 241 F. 2d 147, 156 (1957).

**ATLANTA ECONOMIC REVIEW**

*Published monthly by the*
**Bureau of Business and Economic Research**
**School of Business Administration**
**Georgia State College of Business Administration**
**Noah Langdale, Jr., President**
**33 Gilmer Street, S. E., Atlanta 3, Ga.**

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when one of the objectives set forth in Section 8(b)(4)(A) is present.[12]

The U. S. Court of Appeals sitting in New York and the District of Columbia, however, rejected the *Sand Door* doctrine.[13] These two decisions, along with the *Sand Door* case, were carried to the Supreme Court.

The clear breach indicated by these cases seems to arise from a basic difference in the respective approaches to the hot cargo problem. While the Board and the Ninth Circuit Court have come to the position of measuring the union's activity against the supposed policy and intent of Section 8(b)(4)(A), the other circuit courts compare the union's contract-enforcing efforts against the specific language of the section.[14]

In the fourth significant case, decided after the petitions for review had been filed in the three above cases, the N.L.R.B. again modified its position on the issue. The majority developed what is commonly referred to as the Genuine Parts doctrine[15]—that, where common carriers are involved, the hot cargo clause is invalid at its inception and can be given no operative cognizance so far as the Labor Act is concerned. Two members of the majority of the Board reasoned that common carriers have a public duty under the Interstate Commerce Act which prevents them from withholding their services at will and that a union's signing of a hot cargo contract with a common carrier is *prima facie* evidence of inducement of unlawful boycott, so that merely showing that a shipper has been given preferred carrier service proves a labor law violation. They further added that, under the express provision of the Interstate Commerce Act, common carriers are not free to decide at will to withhold the services they hold themselves out to perform from any customer or class of customers. They are, rather, under a duty to make their facilities available without discrimination or undue preference to all customers willing to meet the conditions of their published tariffs and schedules within the physical limits of their facilities.

### Legal History—Hot Cargo Clause—Interstate Commerce Commission

Like the "hot cargo-unfair labor practice" controversy under the Labor Management Relations Act, the "common carrier's duty to serve" controversy under the Interstate Commerce Act also has an impressive legal history. The development of this litigation up to 1957 is set out in an article by the author entitled "Common Carrier's Duty to Serve Strike-Bound Plants," 24 I.C.C. Practitioners' Journal 30 (October, 1956).

12. Id. 241 F. 2d 147, 154 (1957).
13. **Milk Drivers and Dairy Camp. Local Union v. N.L.R.B., 245 F. 2d 817 (CA-2, 1957) General Drivers Union, Local 886 v. N.L.R.B., 247 F. 2d 71 (CA of D. C., 1957).**
14. Vanderbilt Law Review 635 (1958).
15. **Genuine Parts Co., 119 N.L.R.B. 53 (1957).**

In the key case since 1956, *Galveston Truck Lines v. Ada Motor Lines*,[16] the Interstate Commerce Commission in a unanimous decision ruled that common carriers may not bargain away through labor contract provisions their statutory obligation to serve the public. The I.C.C. held unlawful the refusal of certain motor carriers to accept transport interline shipments and then ordered those carriers to cease and desist from practices found to be in violation of the terms, conditions, and limitations of their Commission-granted operating authorities.

The I.C.C. was of the view that it had no jurisdiction to rule on the legality of hot cargo clauses, for the reason that Congress had entrusted such matter to the National Labor Relations Board. It noted, however, that it was concerned not with the legality of the hot cargo clauses as such, but rather was concerned with the actions of the defendant carriers in relation to their obligations to the public under the Interstate Commerce Act, without regard to the terms of any contract which they may have executed with a third party. In other words, a common carrier might not bargain away its statutory obligations to the public and thereby relieve itself of such obligations.

Further, the Commission thought that the Interstate Commerce Act imposes upon common carriers by motor vehicle subject to its jurisdiction the clear and unmistakable duty to provide adequate service, equipment, and facilities for the transportation of property in interstate or foreign commerce within the scope of their holding out to the public. Thus, they are obligated to accept and transport all freight offered to them in accordance with the provisions of their published tariffs. This duty is almost an absolute one. Hence, if the public is to be adequately protected, common carriers must be held strictly accountable for their performance.

The commission rejected the defendant carriers' contention that existing principles should be revised in view of the increasingly prominent role which labor unions have attained in the transportation industry. The Commission said that approval of such a position would accord the defendant carriers, as well as other carriers similarly situated, immunity from violations of the Interstate Commerce Act and would substitute for the regulation of interstate common carriers now vested in the I.C.C. an indirect control by labor organizations.[17]

### U. S. Supreme Court Decision[18]

The simple issue before the Supreme Court was

16. 73 M.C.C., 617 (1957).
17. CCH, Federal Carriers Reports, No. 225 (Dec. 20, 1957).
18. **Local 1976, United Brotherhood of Carpenters and Joiners of America, A.F.L. v. N.L.R.B., 78 S. Ct. 1011 (1958).**

whether the unions could do under a hot cargo clause what they could not do in the absence of such a clause, i.e., induce the employees of a secondary employer to engage in a strike or concerted refusal to perform services in order to force the employer to cease doing business with another employer. The high court adopted a middle ground, ruling that hot cargo agreements are neither a defense for conduct otherwise unlawful under the Act, nor are they invalid of themselves. The critical consideration is what the union actually did to enforce the agreement—whether it merely obtained the voluntary adherence of the employer, which is perfectly legal, or encouraged the employees to refuse to handle the goods, with the object of forcing the employer or another person to cease doing business with some third party, which is unlawful under the provisions of the Act. The court stated that the legislative purpose in enacting the ban on secondary boycotts was to restrict the area of industrial conflict by prohibiting unions from coercing neutral employers through inducement of their employees to strike or concertedly refuse to handle the goods. The purpose was not to protect the public interest from all secondary boycotts no matter how they were brought about.

When a secondary employer agrees to the boycott of goods of another employer, there is no unfair labor practice within the meaning of the secondary boycott provisions of the Act, since Congress did not see fit to extend the protection from such conduct to the general public by any wholesale condemnation of secondary boycotts. The freedom of choice for the employer contemplated by Section 8(b)(4)(A) is a freedom of choice at the time the question to boycott or not arises in a concrete situation. At the same time the court denied that there is any difference under the Act between a hot cargo agreement with a common carrier and such an agreement with any other employer.

The Court made specific reference to the *Galveston Truck Lines* decision of the I.C.C., conceding that the I.C.C. has ruled that a hot cargo clause does not relieve common carriers of their obligation to serve under the Interstate Commerce Act. However, the Court said that that does not necessarily throw out all such clauses for all purposes and also that the N.L.R.B. should not concern itself with whether the carrier has performed its obligations under the Interstate Commerce Act, but with whether the union has performed its obligations not to induce employees in the manner proscribed by the Taft-Hartley Act.

### Analysis

The Court left a somewhat confusing impression by saying that hot cargo clauses are permissible if observed voluntarily. Some observers believe that the effect of the decision that the clause may not be enforced legally is to make such provisions virtually worthless. Some union sources saw in the decision a blow to N.L.R.B. efforts to outlaw hot cargo clauses, and stressed continued ability to induce employers to live up to such agreements.

One union spokesman said, "Under the decision unions are still free to enter into various types of hot cargo or unfair or struck goods agreements, and can enforce them in all ways except the single way of direct appeals or instructions to the employees themselves not to work." He contended National Labor Relations Board efforts to outlaw hot cargo agreements as such "have been halted for all time." He claimed that under the ruling an employer "can be induced by all means short of a strike to live up to his hot cargo commitments." And he said "a hot cargo agreement is legal, and can properly be entered into and enforced by the employer party thereto, but cannot be enforced by the union party, at least by direct appeals to the employees covered."[19]

Several important observations can be made.

1. There is a great possibility that this decision may intensify the problems connected with contractual clauses instead of solving them. Arbitrators in general are required to base their rulings on the clauses in the contract. This ruling could easily result in disregard for contractual agreements and, consequently, could have a negative or disruptive effect upon good industrial relations by lessening the value of collective bargaining as an instrument of industrial peace.[20]

2. What about a union's right to sue an employer for breach of contract if he disregards a hot cargo agreement and discharges employees for refusing to handle the goods? Since the agreements are not invalid of themselves, such suits would appear to be a possibility. But they would raise issues of conflicting public policy, particularly if the employer is a common carrier.[21]

3. A clear indication of legislative intent on hot cargo clauses is needed. Either a clause permitting the parties to avoid operation of the statute as is provided in Section 8(a)(3) or a decisive declaration of illegality of the hot cargo clauses would eliminate much of the present chaos.[22]

4. There is the question of whether or not the employer's consent to a secondary boycott is voluntary. If the employer is dealing with a large, powerful union, the probabilities that he has accepted the hot cargo clause "voluntarily" are decreased.

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19. Herbert S. Thatcher, special counsel to the International Teamsters, quoted in **Transport Topics**, Monday, June 23, 1958, p. 1.
20. Daykin, Legality of the Hot Cargo Clauses, 9 **Labor Law Journal**, 559, 565 (1958).
21. **Labor Relations Reporter**, 42 Analysis 29 (1958).
22. 46 Calif. Law Rev. 113, 136 (March, 1958).

# COST REDUCTION THROUGH OPERATIONS RESEARCH

by

Robert E. Johnson*

The subject of cost reduction is a timely one. Cost reduction is uppermost in every businessman's mind today. Operations Research is no fast panacea for the profit squeeze, it is no sure pain reliever, and assuredly it is no tranquilizer; rather, it is more of a corrector of systemic disorders. The research applications are often discouragingly time-consuming, but I am convinced that the research is well worthwhile.

Concerning Operations Research, private and complicated language has evolved that has frightened many people; terminology has been borrowed from the academic mathematician, and new euphemisms have been developed to keep the secrets of the trade from the uninitiated. The general term for the field is either Operations Research or Scientific Management. In simple terms this means an analysis of how the firm, the process, or what have you, operates, and then the development of a model which will explain that operation. This model should be susceptible to rapid evaluation on paper so that one may project or forecast how the process will react to selected changes in the motivating factors without an actual trial.

One may conceive of this work as having two main areas of focus:

1. Those areas in which the problem is a choice of the lowest combined costs, with one set of costs rising while another set of costs declines.

For instance, at what point do the decreasing unit costs of fewer set-ups, start-ups, etc., balance the increased unit costs of carrying larger inventories? Or again, at what point does the time lost in waiting for service balance the increased cost of more personnel to give better service, let us say, at a store room? Such problems are frequently complicated by policy decisions as, for instance, to the quality of service that one wishes to maintain.

2. Those areas in which future plans are involved and management desires to know the relative costs of alternative courses of action.

For example, which of several potential plant locations will give the lowest costs of transportation for the finished product? Under these circumstances, a mathematical model may be constructed and alternative assumptions used to solve the mathematical equations. Differing results are thus obtained. This permits management to test on paper alternative decisions before investing manpower, money, and materials.

Chart 1 lists some of the tools of Operations Research.

**Chart 1**

**TOOLS OF OPERATIONS RESEARCH**

1. CORRELATION THEORY
2. PROBABILITY THEORY
3. QUEUEING THEORY
4. LINEAR PROGRAMMING
5. INVENTORY THEORY
6. SERVOMECHANISMS
7. INFORMATION THEORY
8. ACTUARIAL TECHNIQUES
9. GAME THEORY

### Correlation Theory

The following type of problem was posed: How much business may we expect our company to handle in 1960, 1965, and 1975?

Many influences affect the volume of business, and mathematical models can help determine which influences are most important in a given case. Let us call the influences "variables." This makes the mathematician feel better, as it is part of his jargon just as our particular product names are a part of ours.

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This article is adapted from a talk given at the Newark Area Accounting Conference in September 1957. It has been subsequently published by the National Electrical Manufacturers Association for its member companies, and essentially the same material has been incorporated in the proceedings of the Spring Middle Atlantic Regional Conference of the American Society for Quality Control.

Chart 2

## CORRELATION STUDIES AT WESTERN ELECTRIC

| SUBJECT | ORGANIZATION |
|---|---|
| TOLL MESSAGES<br>OUTWARD STATION MOVEMENT<br>RESIDENTIAL STATION GAIN<br>TOTAL BELL SYSTEM STATIONS IN SERVICE | PROGRAM PLANNING |
| SPECIFIC COMMODITY PRICE | ENGINEER OF MANUFACTURE |
| GENERAL PRICE INDEXES | PURCHASING<br>ENGINEER OF MANUFACTURE<br>ENGINEER OF DISTRIBUTION |
| NUMBER OF WESTERN ELECTRIC EMPLOYEES<br>JOB SCORES AND COMPENSATION | PERSONNEL |

Correlation techniques permit the evaluation of the importance of these variables and the construction of a mathematical expression that best explains the movements in the series historically. Substituting assumed future values for the variables permits the projection of the series into the future.

It is possible to go one step further mathematically and to develop a calculation of the likely error of the estimates. Probability Theory, which will be discussed later, points out that differences between the actual and the estimate may be expected within certain ranges two out of three times, or 95 out of 100 times, etc.

The correlation technique is useful in the analysis of current results. For instance, if the current actual is outside the probability range of what could be expected from the formula, analysis is called for. The development of the correlation formula may likewise indicate that certain data scheduled for Integrated Data Processing are of so little value that their collection is not worth the effort. The Integrated Data Processing Tools permit rapid solutions of correlation problems.

The technique is applicable in cases in which a function is dependent upon the impact of outside influences. Chart 2 shows some actual applications for which Western Electric has developed estimating equations. Potential applications include not only those of the type shown in the chart, but such fields as the explanation of pay policy, the evaluation of employees' capabilities, and the appraisal of attitudes.

### Probability Theory

As previously mentioned, Probability Theory would place bands about estimates derived from correlation equations. In almost every technique under discussion, probability plays some part. It is one of the oldest techniques of statistics, and yet one of the most spectacular in increasingly new areas of application.

The applications are in two broad general areas:

1. Sampling, i.e., from observing a scientifically selected portion of the whole, we may judge the characteristics of the whole.
2. Evaluation of a given occurrence as to its

Chart 3

## PROBABILITY THEORY

I PRESENT USES

- A. SAMPLING
  1. QUALITY CONTROL
  2. WE MAGAZINE
  3. AUDITING OF VOUCHERS AND TRANSPORTATION BILLS
- B. LIKELIHOOD ESTIMATES
  1. GROUP INSURANCE
  2. LOST TIME ACCIDENTS—MERIT AWARDS
  3. EMPLOYEE DEATHS

II POTENTIAL USES

- A. SIZE AND LOCATION OF EMERGENCY STOCKS
- B. EQUIPMENT REPLACEMENT
- C. MAINTENANCE
- D. EMPLOYEE REQUIREMENTS
  1. TOOL ROOMS
  2. WAREHOUSES
  3. LOADING PLATFORMS

significance; i.e., may it be due purely to chance?

A few examples of the uses of Probability Theory in each category are shown in Chart 3.

Under sampling, quality control is too well-known to need comment, but it should be recognized as a particular sampling application of Probability Theory. Western Electric has used this application of Probability Theory in a number of cases; for instance, to draw at two locations a sample of vouchers for audit. In this case the quality of the job was controlled, the number of pieces of paper audited was reduced about 50 per cent, and errors were turned up which previously had not been uncovered. Similar samples have been designed for the audit of aircraft and railroad transportation bills. A sample of directory pages was able to evaluate the printer's compliance with the contract requirements.

Western Electric has been involved in a number of cases in which the use of probability has been to evaluate current events and to project the likely course of future events. Very recently we were asked to evaluate the claim experience for active employees under the group insurance program during the first three months. From a probability analysis of past experience, the conclusion was that this experience was not unusual; and ranges were set within which the long-run experience might be expected to vary from that which had been observed. A check at six months found claim experience at the anticipated levels.

Recently, Western Electric has used the same probability techniques to develop a number of alternative proposals for a merit award system for accident prevention. The management of one plant had a look at what the costs of alternative programs were likely to be. This has all been accomplished by planning the program on paper without any significant risk of introducing a program that may be too costly.

We recurringly use Probability Theory in connection with personnel problems. Rather frequently there are requests for estimates as to how many members of a certain level of management will die during some future period. After such a morbid chore, it seldom fails that someone calls to ask if he is the person we expect to die. Of course, we do not pretend to be readers of tea leaves.

This most flexible tool should be helpful in the determination of the size and location of emergency stocks, the replacement of equipment, the development of scientific maintenance practices and, as will be seen later, the staffing of toolrooms, warehouses, and loading platforms—to mention only a few cases. The Integrated Data Processing Tools

Chart 4

## RATES, REQUIREMENTS, CAPACITIES

| | FREIGHT RATES ($ PER TON) SUPPLIER TO DESTINATION | | | | | | |
|---|---|---|---|---|---|---|---|
| DESTINATION | $ 1 | $ 2 | $ 3 | $ 4 | $ 5 | $ 6 | TOTAL REQUIREMENTS (TONS) |
| D 1 | $ 6.60 | $11.60 | $19.80 | | | | 633.1 |
| D 2 | 1.80 | 8.40 | 18.60 | | | | 565.3 |
| D 3 | 4.00 | 8.20 | 19.80 | | | | 145.1 |
| D 4 | 5.40 | 10.20 | 20.20 | | | | 261.0 |
| D 5 | 8.00 | 9.00 | 13.60 | | | | 201.3 |
| D 6 | 2.80 | 6.60 | 17.00 | | | | 358.0 |
| D 7 | 2.20 | 4.60 | 15.40 | | | | 692.9 |
| D 8 | 9.40 | 8.60 | 8.00 | | | | 442.0 |
| D 9 | 6.40 | 2.60 | 18.40 | | | | 970.6 |
| D 10 | 17.40 | 16.60 | 14.80 | | $ 5.60 | | 1,404.4 |
| D 11 | 8.40 | 15.40 | 5.20 | | 9.20 | | 444.9 |
| D 12 | 20.00 | 18.00 | 20.00 | | 12.40 | | 152.3 |
| D 13 | 20.20 | 23.60 | 19.40 | | 13.20 | | 304.1 |
| D 14 | 8.00 | 14.00 | 6.40 | | | | 317.0 |
| D 15 | 8.80 | 11.00 | 6.60 | | | | 552.6 |
| D 16 | 8.00 | 13.60 | 4.40 | | 9.60 | | 49.7 |
| D 17 | 6.40 | 14.60 | 2.80 | | | | 44.4 |
| D 18 | 2.80 | 17.00 | 5.80 | | | | 185.8 |
| D 19 | 4.80 | 22.60 | 8.40 | | | | 282.2 |
| D 20 | 13.00 | 22.80 | 17.20 | | | | 251.1 |
| D 21 | 7.80 | 19.80 | 8.00 | | | | 440.3 |
| D 22 | 15.00 | 30.60 | 21.20 | 15.00 | | | 270.1 |
| D 23 | 23.20 | 29.00 | 23.20 | 19.00 | 21.20 | | 163.8 |
| D 24 | 20.80 | 18.00 | | 24.20 | 21.00 | | 313.6 |
| D 25 | 29.40 | 36.80 | 30.80 | 7.13 | | | 1,020.7 |
| D 26 | 25.80 | 23.00 | 34.20 | | | $ 2.80 | 931.4 |
| D 27 | 26.40 | 23.00 | 34.20 | | | 10.20 | 499.9 |
| D 28 | 25.60 | 22.80 | 34.00 | | | 19.60 | 226.5 |
| D 29 | 25.60 | 22.80 | 34.00 | | | 16.80 | 206.9 |
| SUPPLIER'S CAPACITY (TONS) | 4,115.6 | 2,540.2 | 2,332.3 | 642.7 | 1,310.5 | 1,389.7 | 12,331.0 |

Chart 5

## DOLLAR VALUE OF SHIPMENT COST — ACTUAL SHIPMENTS

| | TONS SHIPPED | | | | | | |
|---|---|---|---|---|---|---|---|
| DESTINATION | S 1 | S 2 | S 3 | S 4 | S 5 | S 6 | TOTAL REQUIREMENTS |
| D 1 | 559.9 | 48.0 | 25.2 | | | | 633.1 |
| D 2 | 517.8 | 47.5 | | | | | 565.3 |
| D 3 | 40.7 | 39.5 | 64.9 | | | | 145.1 |
| D 4 | 88.4 | 135.3 | 37.3 | | | | 261.0 |
| D 5 | 3.8 | 177.3 | 20.2 | | | | 201.3 |
| D 6 | 147.0 | 166.1 | 44.9 | | | | 358.0 |
| D 7 | 272.4 | 362.8 | 57.7 | | | | 692.9 |
| D 8 | 105.3 | 30.0 | 306.7 | | | | 442.0 |
| D 9 | 139.4 | 627.9 | 203.3 | | | | 970.6 |
| D 10 | 45.0 | 1.2 | 214.8 | | 1,143.4 | | 1,404.4 |
| D 11 | 27.1 | 50.0 | 306.7 | | 61.1 | | 444.9 |
| D 12 | | 84.8 | 32.0 | | 35.5 | | 152.3 |
| D 13 | 105.5 | 51.7 | 76.4 | | 70.5 | | 304.1 |
| D 14 | 15.0 | 2.9 | 299.1 | | | | 317.0 |
| D 15 | 195.0 | 10.3 | 347.3 | | | | 552.6 |
| D 16 | | 1.2 | 48.5 | | | | 49.7 |
| D 17 | 25.1 | 4.7 | 14.6 | | | | 44.4 |
| D 18 | 123.5 | 52.8 | 9.5 | | | | 185.8 |
| D 19 | 241.5 | 7.4 | 33.3 | | | | 282.2 |
| D 20 | 201.2 | 1.2 | 48.7 | | | | 251.1 |
| D 21 | 401.1 | 14.5 | 24.7 | | | | 440.3 |
| D 22 | 265.4 | 1.4 | 3.3 | | | | 270.1 |
| D 23 | 63.7 | 45.1 | 37.4 | 17.6 | | | 163.8 |
| D 24 | 125.4 | 172.3 | 15.9 | | | | 313.6 |
| D 25 | 332.2 | 13.5 | 49.9 | 625.1 | | | 1,020.7 |
| D 26 | | 3.1 | 8.3 | | | 920.0 | 931.4 |
| D 27 | 6.0 | 22.5 | 1.7 | | | 469.7 | 499.9 |
| D 28 | 32.0 | 194.5 | | | | | 226.5 |
| D 29 | 36.2 | 170.7 | | | | | 206.9 |
| TOTAL | 4,115.6 | 2,540.2 | 2,332.3 | 642.7 | 1,310.5 | 1,389.7 | 12,331.0 |

SHIPMENT COST—ACTUAL SHIPMENTS $114,952.52

will speed such solutions.

**Queueing Theory**

Queueing Theory is a specialized application of Probability Theory. It relates to the problem of getting the best solution in the case in which demand for service is irregular, such as employees arriving at the tool crib. How many people should be servicing those arriving at a tool crib so that the waiting time is a minimum, the idle time of service people is at a minimum, and the chance is that the waiting line does not exceed more than a given number of people more often than management desires — i.e., the point of balance at which total costs are at a minimum. Western Electric has not been called upon to handle any problems in this area. Practical applications have, however, been made on telephone switching, airline and railroad traffic, machine breakdowns, cafeterias, etc. The technique is useful in any area in which there are inputs or arrival of units and outputs of service, and there are probably many activities in every company in which this tool can be used to advantage.

**Linear Programming**

Linear Programming is one of the newer tools of Operations Research, and one with which we have had spectacular results.

Strand wire will be used to illustrate the general nature of transportation type problems and the nature of the solutions that can be achieved. You will note that on Chart 4 the values on the extreme right show the requirements of each distributing house or warehouse. The bottom row of numbers indicates either capacity of the supplier or the orders placed. In effect, these represent limitations or, as we say in the trade, "restrictions" upon the problem. The values in the body of the table are the costs associated with moving one ton of product from the supplier to the distributing house. Note that with very few exceptions no two suppliers have the same cost to any house. The fundamental problem, then, is to arrange all of the shipments in such a way as to minimize the total combined cost of transportation and price. This may sound simple, but there are actually an infinitely large number of ways in which these shipments can be arranged and still satisfy the needs of the houses. However, there is only one solution that minimizes the total cost. Linear Programming can determine that one best solution.

Let us review what has actually happened in the distribution of this product. Chart 5 shows the

actual 1953 shipments. It is interesting to note that 25 of the 29 houses received products from more than two suppliers. In fact, in six cases four or more suppliers furnished material to one destination. For that matter, the Chicago House received strand from Sparrows Point, Md., while the Baltimore and Washington houses were serviced from Gary, Ind. Costs varied all over from supplier to supplier for any specific house, thus making multiple sources to any house an extremely costly proposition. However, this is exactly the kind of thing that will happen under the pressure of everyday operation in the face of a large number of choices and in the absence of a road map which the tools of Operations Research can provide.

Chart 6 shows the road map developed by Linear Programming within the given limitations of the orders placed upon the suppliers. Here you will note that every house receives its requirements and the commitments to each supplier are fulfilled. In only five houses are shipments received from more than one source and in no case more than two. A savings of $15,467, or nearly 15 per cent, was realized over the actual transportation costs.

Chart 7 depicts an ideal program; that is, each house receives all of its supplies from the lowest cost supplier although the quantity furnished by the several suppliers has been changed. Here the saving is nearly 30 per cent. Ideal programs are seldom completely feasible.

Thus, the decision-makers have been given: (1) a road map for the most economical distribution of strand with the volume from each supplier as stated, and (2) a price tag on a rearrangement of ordered quantities from each supplier to achieve the lowest costs. In the latter case, the buyer may be able to, or wish to, change the order quantities.

Western Electric has operated under such a Linear Program for two years and has achieved substantially the indicated savings.

Chart 8 shows actual and potential applications of these techniques.

A similar problem for pole line hardware indicates potential savings in laid-down total costs of about $175,000, or approximately five per cent. This problem involved the simultaneous manipulation of some 4,600 interrelated variables. It would take about one employee-year to reach a solution manually. Here we turned to the Integrated Data Processing Tools. An IBM 650 computer solved the problem in eight hours. An IBM 705 would probably

(Continued on page 12)

Chart 6

## FINAL LINEAR PROGRAM

| | TONS SHIPPED | | | | | | |
|---|---|---|---|---|---|---|---|
| DESTINATION | S 1 | S 2 | S 3 | S 4 | S 5 | S 6 | TOTAL REQUIREMENTS |
| D 1 | 633.1 | | | | | | 633.1 |
| D 2 | 565.3 | | | | | | 565.3 |
| D 3 | 145.1 | | | | | | 145.1 |
| D 4 | 261.0 | | | | | | 261.0 |
| D 5 | 14.6 | 186.7 | | | | | 201.3 |
| D 6 | 358.0 | | | | | | 358.0 |
| D 7 | 692.9 | | | | | | 692.9 |
| D 8 | | 442.0 | | | | | 442.0 |
| D 9 | | 970.6 | | | | | 970.6 |
| D 10 | | | 93.9 | | 1,310.5 | | 1,404.4 |
| D 11 | | | 444.9 | | | | 444.9 |
| D 12 | | 152.3 | | | | | 152.3 |
| D 13 | | | 304.1 | | | | 304.1 |
| D 14 | | | 317.0 | | | | 317.0 |
| D 15 | | | 552.6 | | | | 552.6 |
| D 16 | | | 49.7 | | | | 49.7 |
| D 17 | | | 44.4 | | | | 44.4 |
| D 18 | 185.8 | | | | | | 185.8 |
| D 19 | 282.2 | | | | | | 282.2 |
| D 20 | 251.1 | | | | | | 251.1 |
| D 21 | 78.4 | | 361.9 | | | | 440.3 |
| D 22 | 270.1 | | | | | | 270.1 |
| D 23 | | | 163.8 | | | | 163.8 |
| D 24 | | 313.6 | | | | | 313.6 |
| D 25 | 378.0 | | | 642.7 | | | 1,020.7 |
| D 26 | | | | | | 931.4 | 931.4 |
| D 27 | | 41.6 | | | | 458.3 | 499.9 |
| D 28 | | 226.5 | | | | | 226.5 |
| D 29 | | 206.9 | | | | | 206.9 |
| TOTAL | 4,115.6 | 2,540.2 | 2,332.3 | 642.7 | 1,310.5 | 1,389.7 | 12,331.0 |

| | |
|---|---|
| SHIPMENT COST — ACTUAL SHIPMENTS | $114,952.52 |
| FINAL PROGRAM | 99,495.17 |
| SAVINGS—FINAL OVER ACTUAL | 15,457.35 |

# SEPTEMBER 1958
# ATLANTA AREA ECONOMIC INDICATORS

| Item | September 1958 | August 1958 | % Change | September 1957 | % Change | % Change Nine Months '58 over Nine Months '57 |
|---|---|---|---|---|---|---|
| **EMPLOYMENT** | | | | | | |
| Job Insurance (Unemployment) Payments | $665,277 | $724,792 | −8.2 | $368,831 | +80.4 | +105.9 |
| Job Insurance Claimants† | 7,332 | 9,982 | −26.5 | 5,084 | +44.2 | +100.1* |
| Total Non-Ag. Employment | 344,050 | 342,300r | +0.5 | 349,250r | −1.5 | −0.1* |
| Manufacturing Employment | 78,550 | 78,600r | −0.1 | 85,900r | −8.6 | −11.3* |
| Average Weekly Earnings, Factory Workers | $77.03 | $81.00 | −4.9 | $74.66 | +3.2 | +3.0* |
| Average Weekly Hours Factory Workers | 39.5 | 40.3r | −2.0 | 39.5 | 0.0 | −0.5* |
| Index of Help Wanted Ads (Seasonally Adjusted, 1947-49 Avg.=100) | 118.4 | 125.4 | −5.6 | 145.2 | −18.4 | −25.6 |
| **CONSTRUCTION** | | | | | | |
| Number of Building Permits§ | 646 | 731 | −11.6 | 601 | +7.5 | +2.3 |
| Value of Building Permits§ | $7,552,521 | $5,027,275 | +50.2 | $5,068,190 | +49.0 | +53.7 |
| Employees | 24,150 | 24,550 | −1.6 | 20,800r | +16.1 | +9.1* |
| **FINANCIAL▲** | | | | | | |
| Bank Debits (Millions) | $1,765.7 | $1,635.6 | +8.0 | $1,599.6 | +10.4 | +1.9 |
| Bank Deposits (Millions) (Last Wednesday) | $1,241.3 | $1,222.4 | +1.5 | $1,116.1 | +11.2 | +11.2** |
| **OTHER** | | | | | | |
| Postal Receipts§ | $1,677,663 | $1,649,189 | +1.7 | $1,380,535 | +21.5 | +10.2 |
| Department Store Sales Index (Adjusted 1947-49=100) | 158 | 183 | −13.4 | 154r | +2.6 | +3.0¶ |
| Retail Food Price Index (1947-49=100) | 118.4 | 118.5 | −0.1 | 115.4 | +2.6 | +2.6** |
| Number Telephones in Service | 317,444 | 317,770 | −0.1 | 297,749 | +6.6 | +6.6** |
| Consumer Price Index | 124.6 | (June) 124.9 | −0.2 | 122.2 | +2.0 | |

r—Revised *Average month **End of period ¶—Based on retail dollar amounts
§City of Atlanta only. N. A.—Not Available ▲Data from members of the Federal Reserve System only.
†New series. Covers unemployed federal employees and unemployed veterans in addition to those covered by Georgia law. Claimants include both the unemployed and those with job attachments, but working short hours.

Sources: All data on employment, unemployment, hours, and earnings: Employment Security Agency, Georgia Department of Labor; Number Help Wanted Ads: Atlanta Newspapers, Inc.; Building permits data: Office of the Building Inspector, Atlanta, Georgia; Financial data: Board of Governors, Federal Reserve System; Postal data: Atlanta Post Office; Retail Food Price Index: U. S. Department of Labor; Department Store Sales Index: Federal Reserve Bank of Atlanta and Board of Governors, Federal Reserve System; Telephones in Service: Southern Bell Telephone and Telegraph Company.

# ATLANTA BUSINESS ACTIVITY

Business activity continued at about the August level in September as seasonal factors brought decreased activity to some industries and increased activity to others. The upturn in **employment** continued with a gain of 1,750 over August, with principal gains occurring in trade establishments and government employment. The Georgia Department of Labor, Employment Security Agency, reports that retail department, apparel, and grocery stores, as well as automobile establishments reported more business in September, accounting for the increase in employment in trade establishments. Net government employment rose 750 workers, with the reopening of schools after summer vacation accounting for most of the increase.

A further cheering aspect of the current Atlanta situation is the drop in **unemployment** which has occurred since June when the number of unemployed reached a peak. The table below shows both actual estimated unemployment and per cent of the labor force unemployed from January 1956 to date.

**Table 1**
**ESTIMATED UNEMPLOYMENT**
**ATLANTA METROPOLITAN AREA**

| | 1956 | | 1957 | | 1958 | |
|---|---|---|---|---|---|---|
| Month | No. | %* | No. | %* | No. | %* |
| January | 9,500 | 2.4 | 12,500 | 3.1 | 18,300 | 4.5 |
| February | 8,150 | 2.1 | 13,950 | 3.5 | 21,250 | 5.2 |
| March | 10,000 | 2.5 | 12,900 | 3.3 | 22,300 | 5.5 |
| April | 8,100 | 2.1 | 11,800 | 2.9 | 22,450 | 5.6 |
| May | 10,300 | 2.6 | 12,150 | 3.0 | 21,200 | 5.3 |
| June | 8,700 | 2.3 | 14,200 | 3.5 | 23,000 | 5.7 |
| July | 10,650 | 2.7 | 13,550 | 3.1 | 20,600 | 5.1 |
| August | 9,000 | 2.3 | 12,850 | 3.2 | 18,250 | 4.5 |
| September | 10,100 | 2.5 | 11,650 | 2.9 | 16,550 | 4.1 |
| October | 12,900 | 2.1 | 12,900 | 3.2 | | |
| November | 9,900 | 2.2 | 13,550 | 3.3 | | |
| December | 11,000 | 2.7 | 15,650 | 3.8 | | |

*Per cent of labor force.

Source: Unemployment figures are estimates of the Employment Security Agency. Percentage figures were computed in the Bureau of Business and Economic Research.

A further reflection of the easing in the unemployment situation is the drop in the number of **claimants for job insurance** and in the amount of **job insurance payments.** Both figures are down sharply from highs reached in recent months, but are still very much above the 1955-56 levels. Employment dipped sharply during the first five months of 1958, and has risen just as sharply during the last four months. The total number employed in September of this year is just slightly above the average month of 1957.

Construction activity has held up well during the entire recession period. The **number of permits** issued for one-family dwelling units, strongly augmented by the "221" type housing associated with urban renewal, has fluctuated widely during the January to October period of this year, but at the current rate the total by year's end will be close to the record high set in 1954. The estimated **value of the construction** for which permits have been issued during the January to October period has also been large and in all likelihood will establish a new record. The total number of permits of all types, however, has lagged somewhat behind the 1954-56 period, indicating that quite a lot of heavy building has been represented in the figures for value. **Employment in construction** has kept pace with the rising valuation figures. Typically, employment in construction rises from a seasonal low in January or February, reaches a peak in June or July, and then gradually falls back to or near its low point to start the whole cycle again in the new year. The upward movement this year began in March and rose by large jumps, reaching a high for the year in August —almost 14 per cent above the high of the year before. The September construction employment figure was 24,150, which was 16 per cent above the same month in 1957.

**Bank debits** were 8 per cent higher in September than in August, and the total was 10 per cent higher in September 1958 than in the same month last year. This reflects, in general, a higher level of spending during these months. For the nine month period ending in September bank debits for the city were about 2 per cent above the same period last year.

[End]

## COST REDUCTION THROUGH OPERATIONS RESEARCH

(Continued from page 9)

reach a solution in less than one hour.

The technique has been applied to plant location problems and to product mix problems. For incoming and outgoing freight costs, one plant location problem showed a difference of nearly $1 million annually between the most costly and the least costly of several locations. A product mix problem showed a difference in freight charges of about $250,000 annually between the most and least costly product mixes. Management decision-makers were given a price tag on one aspect of the problem.

This technique is especially applicable under today's conditions, in which the demand for products stretches capacity to the ultimate. It permits the maximum output within the limits of policy and other restrictions. It identifies and places a price tag on bottlenecks, which should aid in decisions about such conditions. With only slight modifications the technique will show the best use of existing facilities if demand should be less than existing capacities, which is a growing tendency.

Linear Programming is useful when such objectives as costs, profits, efficiencies, or quantities produced are desired at the best level subject to certain limitations, such as may arise from government, marketing, business, production, storage, raw materials, or legal restrictions. Its potential applications within any company are multitudinous, not only for large problems, but even for the scheduling of machines in a small shop. The Integrated Data Processing Tools will permit the rapid development of this field. Integrated Data Processing may find that more data will be needed, but if $1 spent for more data can save $2 or more, it may be worthwhile.

**Inventory Theory**

Operations Research has developed a tool to aid in solving problems connected with investment or

**Chart 7**

**IDEAL PROGRAM**

| | TONS SHIPPED | | | | | | |
|---|---|---|---|---|---|---|---|
| DESTINATION | S 1 | S 2 | S 3 | S 4 | S 5 | S 6 | TOTAL REQUIREMENTS |
| D 1 | 633.1 | | | | | | 633.1 |
| D 2 | 565.3 | | | | | | 565.3 |
| D 3 | 145.1 | | | | | | 145.1 |
| D 4 | 261.0 | | | | | | 261.0 |
| D 5 | 201.3 | | | | | | 201.3 |
| D 6 | 358.0 | | | | | | 358.0 |
| D 7 | 692.9 | | | | | | 692.9 |
| D 8 | | | 442.0 | | | | 442.0 |
| D 9 | | 970.6 | | | | | 970.6 |
| D 10 | | | | | 1,404.4 | | 1,404.4 |
| D 11 | | | 444.9 | | | | 444.9 |
| D 12 | | | | | 152.3 | | 152.3 |
| D 13 | | | | | 304.1 | | 304.1 |
| D 14 | | | 317.0 | | | | 317.0 |
| D 15 | | | 552.6 | | | | 552.6 |
| D 16 | | | 49.7 | | | | 49.7 |
| D 17 | | | 44.4 | | | | 44.4 |
| D 18 | 185.8 | | | | | | 185.8 |
| D 19 | 282.2 | | | | | | 282.2 |
| D 20 | 251.1 | | | | | | 251.1 |
| D 21 | 440.3 | [illegible] | | | | | 440.3 |
| D 22 | 270.1 | [illegible] | | | | | 270.1 |
| D 23 | | | | 163.8 | | | 163.8 |
| D 24 | | 313.6 | | | | | 313.6 |
| D 25 | | | | 1,020.7 | | | 1,020.7 |
| D 26 | | | | | | 931.4 | 931.4 |
| D 27 | | | | | | 499.9 | 499.9 |
| D 28 | | | | | | 226.5 | 226.5 |
| D 29 | | | | | | 206.9 | 206.9 |
| TOTAL | 4,286.2 | 1,284.2 | 1,850.6 | 1,184.5 | 1,860.8 | 1,864.7 | 12,331.0 |
| ACTUAL | 4,115.6 | 2,540.2 | 2,332.3 | 642.7 | 1,310.5 | 1,389.7 | 12,331.0 |
| CHANGE | 170.6 | —1,256.0 | —481.7 | 541.8 | 550.3 | 475.0 | .0 |

| | | |
|---|---|---|
| SHIPMENT COST — ACTUAL SHIPMENT | | $114,952.52 |
| IDEAL PROGRAM | | 83,764.01 |
| SAVINGS | | 31,188.51 |

Chart 8

## LINEAR PROGRAMMING

### ACTUAL APPLICATIONS

| TYPE | ORGANIZATION | POTENTIAL OR ACTUAL SAVINGS |
|---|---|---|
| PLANT LOCATION | | |
| NEW CABLE PLANT | ENGINEER OF MANUFACTURE | $1,000,000 |
| PLANT E | ENGINEER OF MANUFACTURE | — |
| PRODUCT MIX—EXCHANGE CABLE | ENGINEER OF MANUFACTURE | $ 250,000 |
| POLE LINE HARDWARE | PURCHASING | $ 175,000 |
| STRAND | PURCHASING | $ 15,000 |

### POTENTIAL APPLICATIONS

| TYPE | ORGANIZATION |
|---|---|
| MACHINE SHOP SCHEDULING | MANUFACTURING |
| OPTIMUM USE OF CAPACITY | MANUFACTURING |
| A) OVERTIME | |
| B) ADDITIONAL FACILITIES | |
| INVENTORY | MANUFACTURING, MERCHANDISE |

### OBJECTIVES

1) MINIMUM COSTS
2) MAXIMUM PROFITS AND EFFICIENCY

inventory. It is termed either Inventory Theory or Economic Lot Size Theory. It matters little which it is called, for actually we are striving for that point at which the lowest cost is achieved for the company when the combined costs of carrying inventory and production or purchasing costs are a minimum; or, stated another way, it is that amount of the manufacturing or purchased lot size at which the two costs are equal. In fact, on occasion it may be cheaper to carry more inventory in order to achieve the greatest over-all savings from the economic lot size. Operations Research permits us to know the best answer. The methodology is still developing, but practical savings are now possible. My team has added to this development and pushed the theoretical frontier out in two instances.

Let us look at a couple of problems in which we have been involved. One plant is testing an inventory model which we have developed for handsets. The answer involved the solution of several questions: for instance, the economic lot size of production; frequency of production runs; and, most importantly, keeping the whole system geared to dynamically fluctuating demand. We believe that we have developed a system which can be programmed on an IBM 650 computer. The system incorporates a feed-back of data, called a Servomechanism, to gear inventories and economic lot sizes of production to shifting demand. The system will indicate the size and the frequency of the production run for some 250 product codes. We believe that inventory will be some 25 per cent lower than that which empirical judgment would have indicated. We believe that the model will stabilize employment and thereby reduce costs.

Chart 9 shows the factors encountered in most inventory problems. In general, the shopman is torn between the cost of carrying inventory and producing as much as he would like for the improved efficiency gained by spreading his set-up costs over a large number of units. You will note that the cost of carrying inventory rises as the lot size increases, and that the set-up, start-up, and associated clerical costs drop sharply as the lot size increases. The point of intersection is the lowest total variable cost, or the point at which the cost of carrying inventory equals the start-up and other costs associated with producing that quantity. This point of equality of competing costs can be computed precisely. We note that the total variable costs drop sharply for the smaller lot sizes, and then stabilize in a long flat area. This area has two advantages:

1. The determination of costs need not be precisely accurate.
2. The decision-makers have a considerable range of flexibility.

Chart 10 shows the mathematical formulation of the problem. The first formula explains total variable costs. They consist of the cost of carrying inventory and the costs of set-ups, start-ups, and associated items. In the formula, Q equals manufacturing lot size, C equals cost per unit, I equals cost of carrying inventory, Y equals monthly demand, and S equals start-up and associated costs. The 2 under QC indicates that you carry in inventory for a specific time period, in this case one month, on the average one-half of the quantity produced. The 12 under I indicates that we have a monthly formula, while I is an annual figure. TVC

Chart 9

## VARIABLE COSTS ASSOCIATED WITH MANUFACTURING LOT SIZES

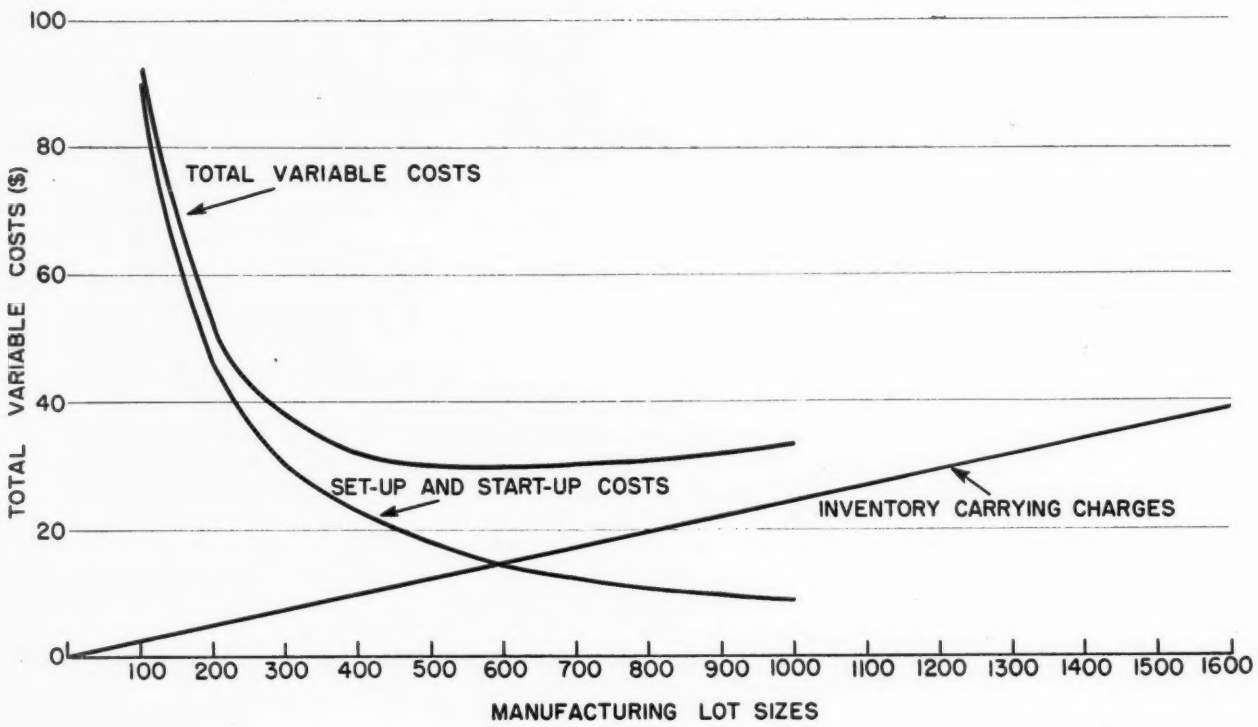



Chart 10

## COST COMPARISONS ASSOCIATED WITH VARYING LOT SIZE PRODUCTION

1 $$TVC = \left(\frac{QC}{2}\right)\left(\frac{I}{12}\right) + \frac{Y}{Q}S$$

COST OF CARRYING AVERAGE MONTHLY INVENTORY

TOTAL SET UP COST IN PRODUCING Y UNITS

TVC = TOTAL VARIABLE COSTS PER MONTH AS DEVELOPED FROM

Q = MANUFACTURING LOT SIZE

C = COST PER UNIT

I = ANNUAL CARRYING CHARGES FOR OBSOLESCENCE, INVENTORY, SPACE, ETC.

Y = MONTHLY DEMAND

S = START UP, SET UP, AND CLERICAL COST

2 $$\frac{QC}{2}\left(\frac{I}{12}\right) = \frac{Y}{Q}S$$

3 $$Q = \sqrt{\frac{24YS}{CI}}$$

is a minimum when the point where the cost of carrying inventory equals the cost of production of the best lot size. So these two items are set as two sides of an equation or, as in the second formula, $\left(\frac{QC}{2}\right)\left(\frac{I}{12}\right)=\frac{Y}{Q}S$. If this expression is solved for the most economic lot size, we have $Q=\sqrt{\frac{24YS}{CI}}$. What a problem for untrained people to solve that equation for all the products the firm makes or buys!

To simplify the problem and avoid the mathematics, we reduced the problem to two nomographs. A nomograph is merely a graphic method of mathematical calculation. Three well-known shop data—set-up hours, recovered hours, and demand—were used. The rest of the mathematics was hidden in the scales and their positioning. To see how easily it works, assume set-up hours equal to 3, recovered hours equal to 100, and demand equal to 4,000. If a straight edge is laid on 3 on the left-hand scale and 100 on the right-hand scale of Chart 11, 76 is read on the center scale. Carrying this value to Chart 12, a straight edge is laid on 76 on the left-hand scale and 4,000 on the right-hand scale. The economic lot size is read on the center scale as 2,000. Many tests indicate that the values read from the charts are within one per cent of calculation by the formula.

A word of warning at this point. The nomographs must be developed for each area of use. Further, the construction of the nomographs must be precisely designed as to scales and their positioning.

The nomographs have been tested in one of our piece part shops. This shop makes some 20,000 different piece parts. The department chief, by the use of the formula, the nomographs, and related concepts, has raised efficiency from 98 to about 130. Of course, when translated into dollars, this represents savings of a significant amount of money each year, while at the same time service conditions have been improved. The technique is applicable to both production and purchasing problems.

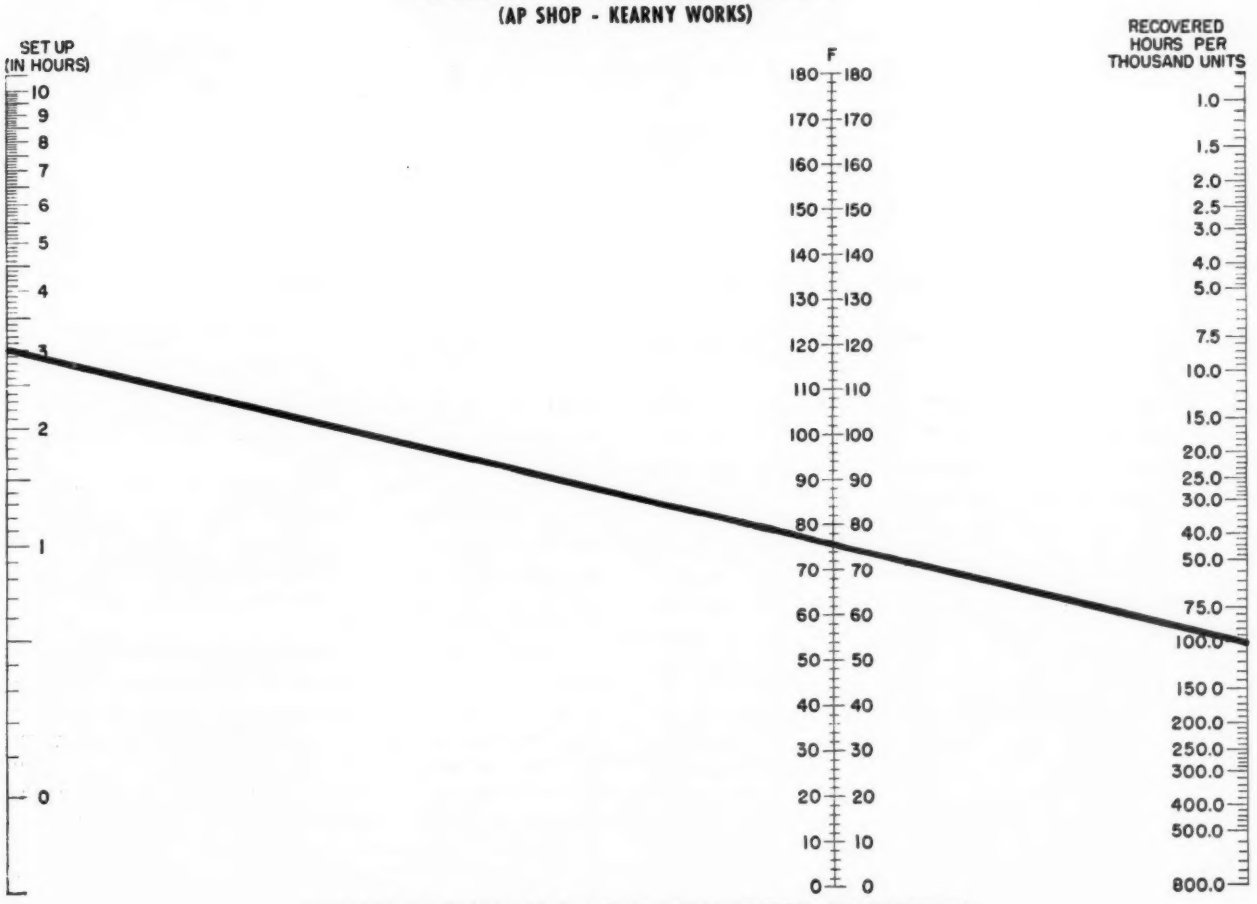
**Servomechanisms**

I alluded to the fact that we had built a servomechanism into the inventory model. Let me dwell

Chart 11

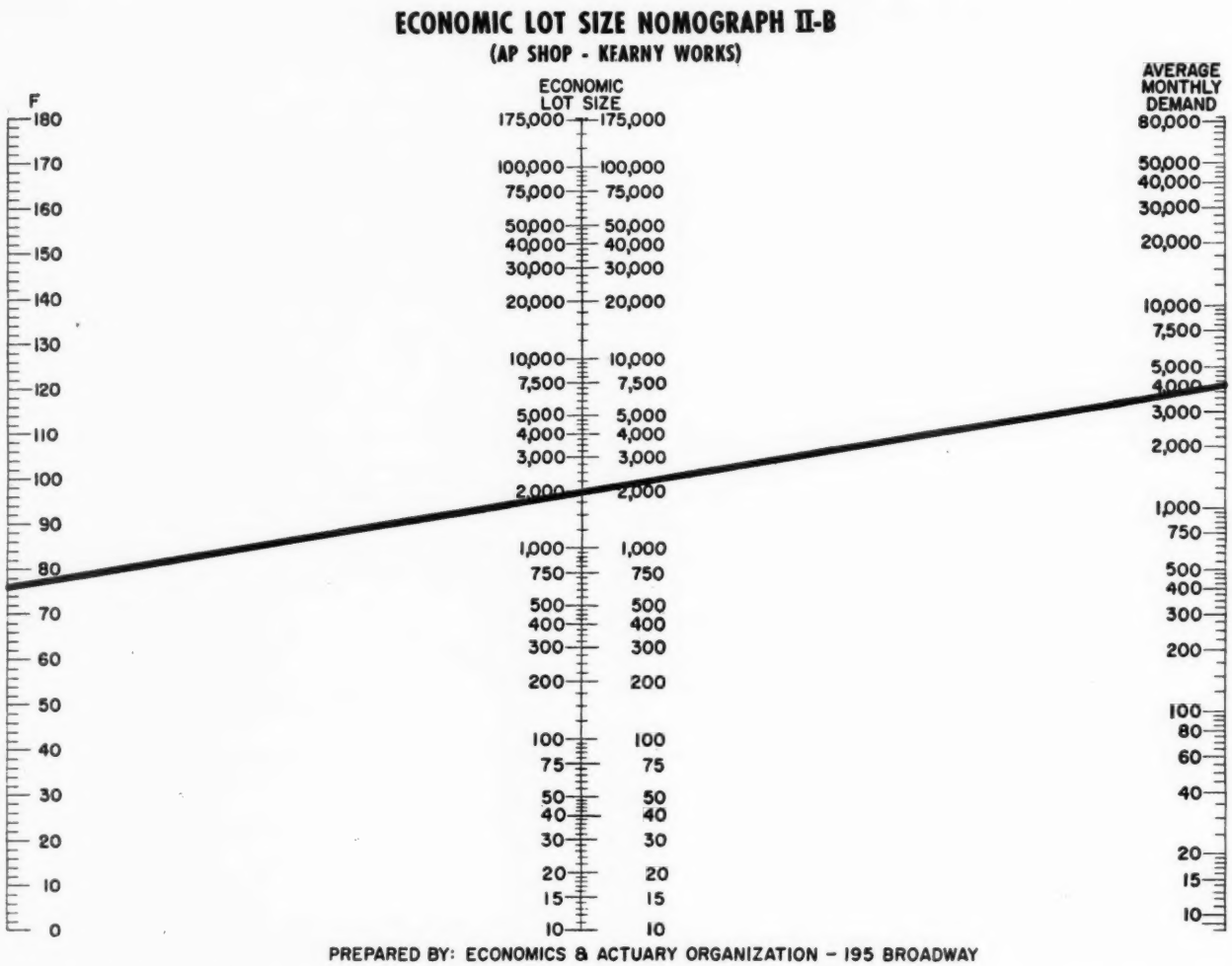
**ECONOMIC LOT SIZE NOMOGRAPH I**

**(AP SHOP - KEARNY WORKS)**




PREPARED BY: ECONOMICS & ACTUARY ORGANIZATION – 195 BROADWAY

Chart 12




just a moment on what I mean by a servomechanism. A servomechanism is essentially the utilization of a feed-back of current data. It is so designed that such information may be utilized as a self-correcting device to the mathematical formulas. In this job, demand is taken as the average actual demand for a selected immediate past period. On the computer this is then programmed as a continuous moving average. Thus, it will be seen that in this case it is not the anticipated program, but the actual near-term past experience which is used. The development of these kinds of servomechanisms involves the use of the theories of runs—that is, the length of time a given movement has been under way as well as both the momentum and the level of the movement. All of this is tested in the light of Probability Theory. Undoubtedly further development of the servomechanism technique is going to rely on both Integrated Data Processing and the Integrated Data Processing Tools, especially the electronic computers. The servomechanism technique should be helpful in gearing production and purchasing to fluctuating demand so as to minimize changes in program. Thus, it may be possible to moderate costly swings in the production cycle.

**Information Theory**

Information and Communication Theory are closely related. Taken together, they may be defined as knowledge of the communication network within an organization, the control processes within that network, and the information actually generated or potentially available.

Analysis of one of Western Electric Company's shops is a typical example of Information Theory within a manufacturing company. Chart 13 depicts the flow of information and physical things into, through, and out of the shop. The solid lines show the information or paper flow which would be desirable. Actually, information was not being communicated throughout the network. Once the need was visualized, procedures were taken to improve the flow of existing data. Overlay No. 1 outlines

the findings of the survey study; for instance, 50 per cent of the orders were late coming into the shop, accounting for 20 per cent of the volume being late. Further, inadequate information was available to allow the shop to calculate its manload. Overlay No. 2 indicates the corrective action suggested: namely, tabulating at using shop level would aid the producing shop ordering. Other findings are shown in the other circles, and recommended actions are shown in the associated boxes. Several of the actions suggested include the use of Operations Research tools, e.g., loading of machines through Linear Programming and the production of Economic Lot Sizes.

The applications of these theories are well-known in the engineering side of our business, but their applications to the management side of the business will probably be a source of significant gains in the years ahead.

### Actuarial Techniques

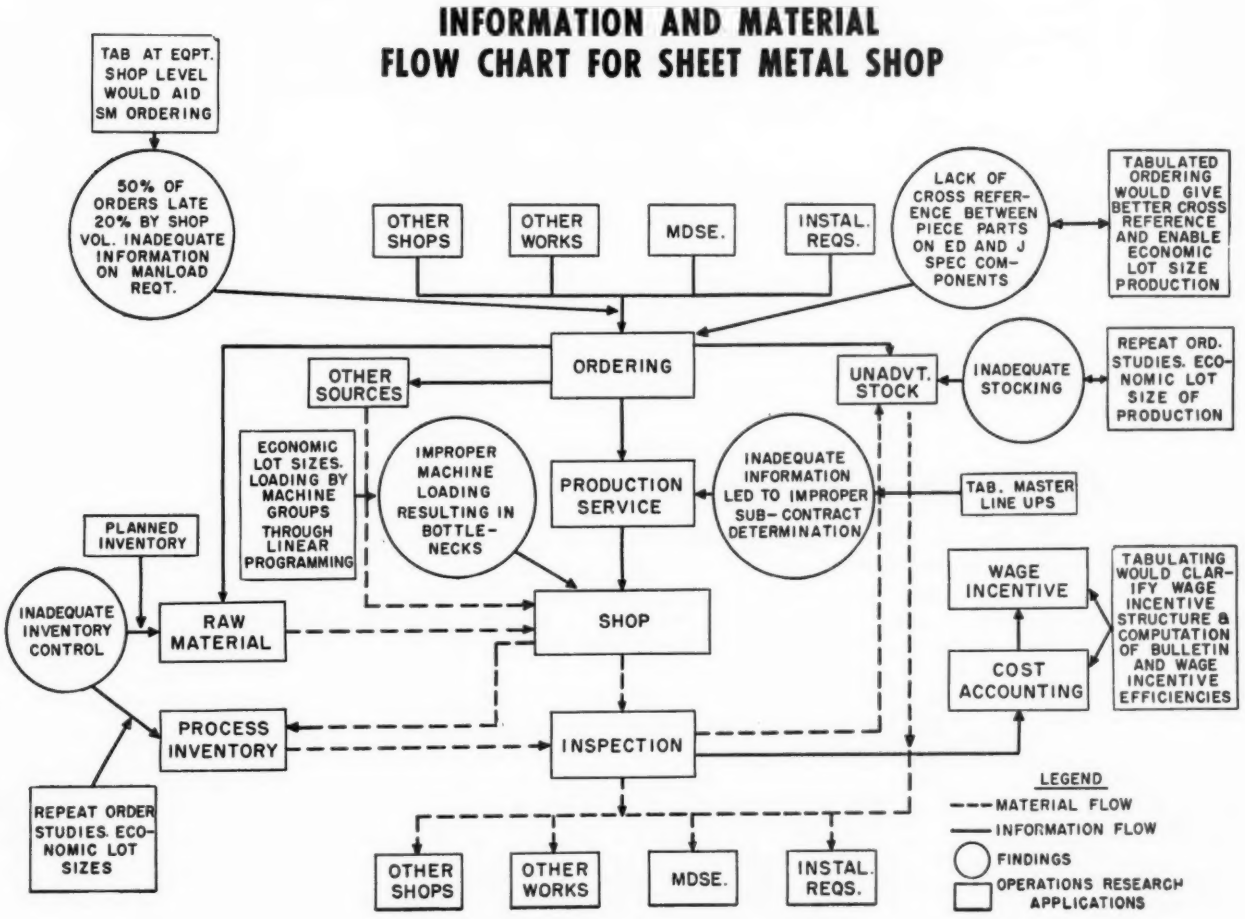
Actuarial Techniques is the borrowing of the methods of the actuary who normally is concerned with the life tables and other vital statistics of human individuals. We have in my office long used these techniques for the development of the accrual rates for pensions, force adjustment, death benefits, and group insurance problems. We have also for a number of years applied the actuarial techniques to the development of depreciation rates. There are many potential fields of application. For instance, if we knew that a product manufactured with, let us say, a 30-year life in fact seldom stayed in service more than 15 years, due to rearrangements and changes, we might develop the product to last 20 years at lower cost and replace the product at older ages. There might be considerable over-all saving.

### Game Theory

Finally, among the Operations Research tools there is the Game Theory. Game Theory is a highly mathematical technique involving opposing strategies. Consider a potential Western Electric Case. Ice storms create sudden demands for emergency shipment of materials. Ice storms occur seasonally at random, both in time and as to geographical area. But the strategies of nature, i.e., the frequency

(Continued on page 20)

**Chart 13**


INFORMATION AND MATERIAL
FLOW CHART FOR SHEET METAL SHOP
TAB AT EQPT. SHOP LEVEL WOULD AID SM ORDERING
50% OF ORDERS LATE 20% BY SHOP VOL. INADEQUATE INFORMATION ON MANLOAD REQT.
OTHER SHOPS
OTHER WORKS
MDSE.
INSTAL. REQS.
LACK OF CROSS REFERENCE BETWEEN PIECE PARTS ON ED AND J SPEC COMPONENTS
TABULATED ORDERING WOULD GIVE BETTER CROSS REFERENCE AND ENABLE ECONOMIC LOT SIZE PRODUCTION
ORDERING
OTHER SOURCES
UNADVT. STOCK
INADEQUATE STOCKING
REPEAT ORD. STUDIES. ECONOMIC LOT SIZE OF PRODUCTION
ECONOMIC LOT SIZES. LOADING BY MACHINE GROUPS THROUGH LINEAR PROGRAMMING
IMPROPER MACHINE LOADING RESULTING IN BOTTLE-NECKS
PRODUCTION SERVICE
INADEQUATE INFORMATION LED TO IMPROPER SUB-CONTRACT DETERMINATION
TAB. MASTER LINE UPS
PLANNED INVENTORY
INADEQUATE INVENTORY CONTROL
RAW MATERIAL
SHOP
WAGE INCENTIVE
TABULATING WOULD CLARIFY WAGE INCENTIVE STRUCTURE & COMPUTATION OF BULLETIN AND WAGE INCENTIVE EFFICIENCIES
COST ACCOUNTING
PROCESS INVENTORY
INSPECTION
REPEAT ORDER STUDIES. ECONOMIC LOT SIZES
OTHER SHOPS
OTHER WORKS
MDSE.
INSTAL. REQS.
LEGEND
MATERIAL FLOW
INFORMATION FLOW
FINDINGS
OPERATIONS RESEARCH APPLICATIONS

# *The Southeastern Corner*

by
Warren A. Walker*

## *THE SOIL BANK IN THE SOUTHEAST*

It goes almost without saying that this is an excessively ambitious title for a short article. The procedure that will actually be employed is to examine in some detail the impact of the soil bank program in a specific and rather restricted area. From these facts we shall then attempt to draw some generalizations that apply to a somewhat broader segment of the southeastern United States.

First of all we must keep in mind that, when compared with past programs, the Soil Bank is different in its approach to controlling farm surpluses. It is not within the scope of this article to evaluate whether this is a better approach, but merely to determine the extent of participation to date and give some of the current aspects of the Soil Bank program.

Before proceeding further it may be well to examine just what constitutes the differences between this agricultural program and those of the past. Briefly stated, the points of variance are as follows: Previous programs have had the aim of preventing a farm surplus in a particular commodity in a particular year, whereas the soil bank attempts by financial inducements to adjust land uses to *long-term* projections, with the attendant conservation of agricultural resources; an additional distinction is that the program is entirely voluntary in both its divisions, the Acreage Reserve and the Conservation Reserve.

Farmers participate under the Soil Bank on a contract basis. Contracts run for three, five, or ten years, and annual payments are made to the farmers on the basis of the land covered and by the terms of the agreement. Additional payments are also made to assist in defraying the costs of establishing certain phases of the conservation programs.

### Experience with the Soil Bank in the Southeast

The only comprehensive sampling of farmers in relation to Soil Bank participation that has come to the writer's attention covered an area designated as the "upper coastal plain" of South Carolina.[1] The

area under consideration is in numerous ways typical of the Southeast in general. The climate is mild, the rainfall adequate but not excessive, and the agriculture diversified; corn and cotton are the primary cash crops.

### *Reasons for Participating*

As might be expected, the survey revealed that land was often placed in the Conservation Reserve because it was more profitable to do so than to produce crops or rent it out. This course of action was reported as occurring least frequently in the case of small farms, most frequently for medium-sized, and almost as often for large farms. Because small farms in the Southeast are generally believed to be the least profitable units, one would have been tempted to believe that they would be making maximum use of the Soil Bank. That is to say, if farming is subject to the "economies of scale" (and there is good reason to believe that it is), presumably the large farms could best utilize mechanized equipment, achieve low-cost production, and, because their operations are profitable, would be the last ones to withdraw acreage from production. But it didn't work out that way; the larger farms have been the ones to make the most use of the Soil Bank.

The explanation of this paradox is not really as difficult as it appears to be. The Southeast is an area of preponderantly small farms—over half of those included in the survey were under 50 acres. One may think of the small-scale farmer as something of a "speculator." His available capital is small, his unit costs are high, and his profit margin is minuscule. Whether he puts his land into the Conservation Reserve or whether he raises crops, his income position is still a marginal one. (There is an old saying that the farmer "lives in hope if

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1. Charles P. Butler and William J. Lanham, "An Economic Appraisal of the Conservation Reserve Program in Area IIIB, Upper Coastal Plain of South Carolina. South Carolina Experiment Station, Clemson Agricultural College, Clemson, S. C., February, 1958.
This survey covered both participating and nonparticipating farmers. For convenience in analyzing the statistical material, two additional breakdowns were also used: (1) tenure of the operator, and (2) the size of the various tracts involved. Owners were distinguished from tenant operators, with an additional breakdown for farmers who owned some land but rented additional acreage. In regard to the breakdown as to the size of the farms under consideration, those under 50 acres were considered as "small," 51 to 150 as "medium-size," and all others as "large" scale operators.

he dies in despair.") Yet he always has the feeling that he might do just a little better by speculating on the return from his crops than he would from the assured income from the government, and it must be admitted that there have been years when crops have paid off well. Following this line of thought, the small-scale farmer is not apt to place his land in the Soil Bank.

On the other hand, the middle-sized farmer is in a different situation. He has too much capital tied up in his farm enterprise to run the risk of speculating on the chance that returns from farming *might* be considerable. However, he is not really large enough to make maximum use of farm machinery. His appraisal of the situation, and it is probably correct, is that he will receive a greater net return—and surely a more certain one—from placing at least his marginal land in the Conservation Reserve. Since he cannot use machinery to the best effect, he must rely on hired labor. For this reason more than twice as large a ratio of medium-scale operators, as compared with large-scale ones, mentioned "shortage of labor" as a reason for participating in the Soil Bank.

Finally there is to consider the situation of the large-scale farmers who as a group have made large use of the Soil Bank Reserve opportunities. The survey revealed that many of them could apparently live comfortably from the income of the Conservation Reserve, even if virtually their entire farms were restricted to this use. As a sort of corollary to this observation, it might be noted that, of those individuals who gave as a motive for participation in the Soil Bank that it "provides a means for retirement," 17 per cent of the large farmers gave such a reason, but only four per cent of the small ones were of this mind.

***Can the Objectives Be Obtained?***

Can the objectives of the conservation of our agricultural resources be obtained by a program of the Soil Bank type? It appears on the basis of this preliminary and rather limited survey that the attainment of this objective may be a distinct possibility. The farmers participating in the program reported that only three per cent of the land put into restricted use was better than other land on their farm, while 96 per cent of it was rated in varying degrees from "about equal" to "much lower" in quality. (The remaining portion of the land was not classified.) An offsetting feature is the fact that some of the land put into the Bank by the participating farmers is of better quality than that kept in production by nonparticipating ones. Nevertheless, looking at the picture as a whole, it appears that the land put into the conservation program has been about equal to the quality of the land which has been retained for agricultural production. Since some 85 per cent of the acreage restricted under the Conservation Reserve will go into pine trees, it would appear that the conservation objective will be realized, especially in such respects as the prevention of erosion, the improvement of top soil conditions, and certain other related features.

While the impact of the Conservation Reserve has been to reduce the amount of land devoted to corn, oats, and soybeans, its greatest impact has been on cotton acreage (which has declined substantially).

**Impact on Other Segments of the Economy**

If we assume that this survey area in South Carolina is in fact a representative sample—and it probably is, then it would appear that farm surpluses will not be reduced either by the amount that had originally been projected or by the amount that the reduction in acreage would seem to indicate. This is true because a large proportion of the really superior crop lands is still being used for that purpose. On the present trends about the best that can be hoped for is that the rate of increase of certain commodity surpluses may be reduced.

Livestock production is unlikely to be substantially influenced by either "reserve" of the Soil Bank program. Farms that already had lands in improved pastures would have had no economic motivation for changing the use of this land.

Shifting from the purely agricultural features of the program to industrial activities, we can feel assured that the impact will be felt here also, especially in the case of farm machinery. Obviously, less farm machinery will be required for areas that are converted to woodlands than was required when these same lands were in row crops. In fact, in the area included in this particular survey the impact will probably be disproportionately great. The small-scale farmers, who use but little machinery anyway, are still producing, whereas the large-chale operators, who employ much equipment, have placed a lot of land into the "reserves" and consequently will not be in the market for much machinery now.

**Impact on Farm Labor**

It is a well-known fact that the number of persons employed on farms has been declining for a number of years and at a fairly rapid rate. There can be very little doubt that the Soil Bank program will accelerate this trend even more. The operators of the participating farms indicated that even without the Soil Bank program they would probably have reduced their workers by about nine per cent. With the Soil Bank program in effect, the actual reduction was twelve per cent between 1956 and 1957.

As with any program involving land use, it may be many years before the full ramifications of the Soil Bank program can be appraised. Of one fact we may be very sure—each and every person in the United States will feel these influences.

[End]

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## COST REDUCTION THROUGH OPERATIONS RESEARCH

(Continued from page 17)

and intensity of storm damage, can be studied, various patterns of storm occurrences can be assigned, and an evaluation of the demands for various materials can be made. Various company strategies can then be taken to supply needed materials from stock most advantageously located, for both assurance of supply and lowest costs. Many practitioners in the Operations Research field apply the title "Game Theory" to the picking of alternative choices when the highly mathematical techniques are not involved.

Summing up, then, these Operations Research approaches have been tried in several situations. So far as I know, each attempt, which has been manned by competent technicians, has shown an actual or yet to be tested potential profit. One danger may exist. It is possible in a decentralized system to make savings in one unit and unwittingly add greater costs than savings in another area. This, then, leads to the need for a central clearing point to assure that the saving is really maximum on a companywise basis, while rendering service and producing quality consistent with top management policies.

The above points may be considered a wide array of diverse applications. Several of the cases outlined may seem to be inapplicable to accountants. But I believe that every case cited affects either the balance sheet or the income statement. One of the problems of accountants is to minimize costs or, stated another way, to maximize profits. Here, then, is a kit of tools with which accountants can guide even the engineer, the production man, or the purchaser to use to affect the income statement, at the same time forming a service of helping each to do his job better.

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